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EPIDERMAL CHARACTERS OF *BACCHARIS* (ASTERACEAE) SPECIES USED IN TRADITIONAL MEDICINE

Caracteres epidérmicos de las especies del género *Baccharis* (Asteraceae) usadas en la medicina popular

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ABSTRACT

A morphological study of 38 species of *Baccharis* used in traditional medicine was carried out to provide some epidermal characters that will contribute to the knowledge of the genus. The present study revealed: 1) seven different types of trichomes: conical, aseptate flagellate, filiform flagellate, 1-armed, 2-4-armed, bulbiferous flagellate, and glandular biseriate; 2) that 28 of the total of 38 species have trichomes in tufts; 3) six different types of stomata: anomocytic, anisocytic, cyclocytic, actinocytic, tetracytic, and staurocytic; 4) that some trichome types, such as 2-4-armed (*B. dracunculifolia*) and aseptate flagellate branched (*B. trinervis*), show a high diagnostic value; 5) that the stomata types can be used to differentiate species with similar trichomes type (e.g. *B. trimera* and *B. articulata*). Illustrations of the studied characters are provided.

Key words. *Baccharis*, Compositae, medicinal species, stomata, trichomes.

RESUMEN

Se realizó un estudio de caracteres epidérmicos de las hojas de las 38 especies de *Baccharis* usadas en la medicina popular. El análisis de los caracteres revela: 1) siete tipos de tricomas: cónicos, flageliforme aseptados, filiformes flagelados, 1-armados, 2-4-armados, bulbíferos flagelados y glandulares biseriados; 2) que 28 especies del total de 38 especies medicinales estudiadas presentan tricomas en "nidos pilosos"; 3) que seis tipos de estomas están presentes: anomocíticos, anisocíticos, ciclocíticos, actinocíticos, tetracíticos y estaurocíticos; 4) que algunos tricomas muestran un alto valor diagnóstico, por ejemplo, los tricomas 2-4-armados son exclusivos de *B. dracunculifolia* y los flagelados-aseptados ramificados están presentes sólo en *B. trinervis*; 5) que los tipos de estomas permiten la diferenciación de especies con igual tipo de tricoma, (por ejemplo *B. trimera* de *B. articulata*). Se incluyen ilustraciones de los caracteres diagnósticos.

Palabras clave. *Baccharis*, Compositae, especies medicinales, aparatos entomáticos, tricomas.

INTRODUCTION

Baccharis L. is one of the largest genera of the tribe Astereae (Nesom, 1994). It comprises c. 400 American species of shrubs or subshrubs, occasionally small trees and herbs, nearly all dioecious.

According to Zin (1922), Amat (1983), Zardini (1984), Girault (1987), Boldt (1989), Correa & Bernal (1990), Iharlegui & Hurrell (1992), Soria (1993), Heinrich (1996), Rojas *et al.* (1999), Pérez-García *et al.* (2001), Erazo *et al.* (2002), Baggio *et al.* (2003), Vidari *et al.* (2003), Souza (2004), and a recent webpage (Harding-Barlow), 38 medicinal species of *Baccharis* with folk medicinal use (or mentioned at least as medicinal herbs) are recognized (Table 1); many of these species can be distinguished by their leaf or winged stem morphology (Appendix 1). In 22 of these species biological activity was tested (Gutkind *et al.* 1981, Vidari *et al.* 2003, Verdi *et al.* 2005). *Baccharis megapotamica* and *B. pedunculata* are also included in this study since they can be considered promisory medicinal species judging from their tested biological activity (Verdi *et al.* 2005).

Heering (1899), Volkens (1890), Quentin (1911), Ariza Espinar (1973), Barroso (1976), Pertusi (1987), Hellwig (1990, 1992), Müller (2006) and, are among authors who have contributed most to the solving taxonomic problems through the analysis of micromorphology of leaf surface in *Baccharis*.

Epidermal traits, i.e. epidermal cells, stomata, and hairs, have proven to be an important tool in taxa delimitation in many plant families (e.g. Lackey 1978, Metcalfe & Chalk 1950-1979, Sinclair & Sharma 1971, Uphof *et al.* 1962), and also in distinguishing medicinal species since drugs of pharmaceutical use are made up of dried and bruised parts in which the different macroscopical characteristics of the species are not generally distinguishable (e.g. Amat, 1988; Rapisarda *et al.*, 1997). Within this context, this study pretend to contribute to the knowledge of the medicinal species of the genus *Baccharis*.

MATERIAL AND METHODS

The study was performed using dried leaves or winged stems (if only bract-like leaves are present) taken from herbarium specimens (Appendix 2). Accepted names, synonyms, vernacular names, distribution, medicinal uses, and biological activity for each studied species are given in Table 1.

The epidermal microcharacters were studied in samples cleared using the technique of Dizeo de Strittmatter (1973), and stained ussing safranin in 80% ethanol. Measurements of stomata (length) were taken using a Nikon light microscope equipped with an ocular micrometer. The average size of stomata was determined based on measurements performed on 15-20 replicates per sample.

Descriptive terminology for the trichomes basically follows Ramayya (1962). Whenever possible, additional synonyms of trichome terminology were added (Ariza Espinar 1973, Metcalfe & Chalk 1989, Müller 2006). The classification of anticlinal epidermal cell wall patterns follows Stace (1965). Stomata types were classified according to Stace (1965), Van Cotthem (1970), Metcalfe & Chalk (1979). The nomenclature of the included species follows Matuda (1957), Cuatrecasas (1967), Ariza Espinar (1973), Barroso (1976), Giuliano (2000) and Oliveira *et al.* (2006). Drawings were made by the authors using a microscope Leitz SM Lux with *camera lucida*.

Table 1. Distribution, vernacular names, folk medicinal uses and tested biological activity of *Baccharis* species. AN = Antilles; AR = Argentina; BO = Bolivia; BR = Brazil; CH = Chile; CO = Colombia; CR = Costa Rica; EC = Ecuador; ES = El Salvador; GU = Guatemala; HO = Honduras; ME = Mexico; NC = Nicaragua; PA = Paraguay; PE = Peru; PN = Panama. UR = Uruguay; US = United States; VE = Venezuela.

Species	Distribution	Vernacular name	Folk medicinal use	Tested biological activity
Baccharis anomala DC. *Pingraea anomala* (DC.) F.H. Hellwig	AR, BR, PA, UR	--	vagina and wounds wash, general infections (Souza, 2004)	--
Baccharis artemisioides Hook. & Arn.	AR, UR	"mío-mío blanco", "pichana blanca", "romerillo", "romerillo blanco", "romerillo malo" (Argentina).	antirrheumatic, for treating traumatisms (Zardini, 1984)	antifeedant (Verdi *et al.*, 2005)
Baccharis articulata (Lam.) Pers. *Conyza articulata* Lam; *Molina articulata* (Lam.) Less.; *Pingraea articulata* (Lam.) F.H. Hellwig	AR, BO, BR, PA, UR	"caápé guasú", "carqueija", "carqueja", "carqueja amarga", "carqueja blanca", "carqueja cenicienta", "carqueja crespa", "carqueja gris", "carquejilla", "chirca melosa" (Paraguay), "cola de yacaré", "planta del yaguareté", "yaguaretá-caá" (Argentina); "carqueja", "carqueja-do-morro", "vassoura" (Brazil).	digestive, hepatoprotective, diuretic, antirrheumatic, antiseptic, for male sexual impotence, for female sterility (Zardini, 1984)	antioxidant (Verdi *et al.*, 2005)
Baccharis boliviensis (Wedd.) Cabrera *Heterothalamus boliviensis* Wedd.; *Pseudobaccharis boliviensis* (Wedd.) Cabrera; *Psila boliviensis* (Wedd.) Cabrera	AR, BO, CH, PE	"chijua", "romero", "tola" (Argentina).	medicinal (Erazo *et al.*, 2002)	antibacterial (Erazo *et al.*, 2002) allelopathic (Verdi *et al.*, 2005)
B. conferta Kunth *Baccharis xalapensis* Kunth; *Baccharis orizabaensis* Sch. Bip. ex Hemsl.	ME	"quauhizquiztli" (Mexico).	for stomach-ache, laxative, stornutatory, for baldness, for insect bites (Heinrich, 1996)	spasmolytic, antibacterial (Verdi *et al.*, 2005)
Baccharis coridifolia DC. *Eupatorium montevidense* Spreng.	AR, BO, BR, PA, UR	"ajenjo del campo", "mío", "mío-mío", "neo-neo", "neomo", "nía", "nío", "niyo", "ñío-ñío", "romerillo" (Argentina); "mio-mio" (Brazil).	digestive, sudorific (Amat, 1983)	antiviral, allelochemical, antioxidant, citotoxic, insecticide (Verdi *et al.*, 2005)
Baccharis crispa Spreng. *Molina crispa* (Spreng.) Less; *M. cylindrica* Less.; *Baccharis cylindrica* (Less.) DC.; *B. genistelloides* var. *crispa* (Spreng.) Baker; *B. genistelloides* var. *cylindrica* (Less.) Baker; *B. perplexa* I.L. Teodoro & J.E. Vidal; *Pingraea crispa* (Spreng.) F.H. Hellwig	AR, BR, PA, UR	"carqueija", "carqueja", "carqueja crespa", "carquejilla" (Argentina), "yaguareté-ka'á" (Paraguay).	digestive, hepatoprotective, antispasmodic, against fever, antirrheumatic, antiseptic (Zardini, 1984)	antibiotic (Gutkind *et al.*, 1981) antifeedant, antimicrobial, antioxidant (Verdi *et al.*, 2005)

Species	**Distribution**	**Vernacular name**	**Folk medicinal use**	**Tested biological activity**
Baccharis decussata (Klatt) Hieron. *Pluchea decussata* Klatt; *Baccharis moritziana* Hieron.	CO, EC, PE, VE	"almanga", "armanga", "machimbí" (Colombia).	antiinflammatory, for favouring scaring (in cows; Correa & Yesid Bernal, 1990)	--
Baccharis douglasii DC. *Baccharis haenkei* DC.	ME, US	--	for treating sores and wounds (Boldt, 1989)	--
Baccharis dracunculifolia DC. *Baccharis leptospermoides* DC.; *B. bracteata* Hook. & Arn.; *B. dracunculifolia* var. *integerrima* Kuntze f. *subviscosa* Kuntze; *B. tandilensis* Speg.; *B. dracunculifolia* f. *spectabilis* Heering	AR, BO, BR, PA, UR	"caápé guasú", "chilca", "chilca-y", "chilca mata ojo", "suncho" (Argentina); "alecrim-de-vassoura", "alecrim-do-campo", "vassourinha" (Brazil).	abortive (Iharlegui & Hurrell, 1992)	--
Baccharis gaudichaudiana DC. *Baccharis articulata* var. *gaudichaudiana* (DC.) Baker	AR, BR, PA, UR	"carqueja" (Argentina, Brazil).	digestive, hepatoprotective, antiseptic (Zardini, 1984)	citotoxic (Verdi *et al.*, 2005)
Baccharis genistelloides (Lam.) Pers. *Conyza genistelloides* Lam.; *Molina reticulata* Ruiz & Pav.; *Baccharis reticulata* (Ruiz & Pav.) Pers.	BO, CH, CO, EC, PE	"charara", "jatun kimsa kuchu", "nuchu-kuchu", "quimsa-kuchu", "tres espigas" (Bolivia); "chilca" (Colombia); "cuchu-cuchu", "muqu-muqu", "nudo-nudo", "qimsa-kuchu" (Peru).	astringent, diuretic, antirrheumatic, for paludism, for gonorrhea, for chest-ache, for stomach-ache (Correa & Yesid Bernal, 1990)	antiviral, gastroprotective (Verdi *et al.*, 2005)
Baccharis genistifolia DC.	AR, BR, UR	--	antispasmodic (Zardini, 1984)	--
Baccharis grisebachii Hieron. *Baccharis abietina* Kuntze; *B. rosmarinifolia* var. *andicola* Hauman	AR, BO	"chilca mamil", "quinchamal", "quinchamalí", "romerillo", "tancha" (Argentina).	for treating wounds (Zardini, 1984)	antimicrobial, citotoxic, protein synthesis (Verdi *et al.*, 2005)
Baccharis heterophylla Kunth *Baccharis cuneata* DC.; *Baccharis spathulata* S. Schauer	GU, ME	--	for gastrointestinal disorders (Rojas *et al.*, 1999)	antimicrobial, spasmolytic (Verdi *et al.*, 2005)
Baccharis illinita DC.	BR, PA	--	for gastric disorders (Baggio *et al.*, 2003)	gastroprotective (Verdi *et al.*, 2005)
Baccharis latifolia (Ruiz & Pav.) Pers. *Molina latifolia* Ruiz & Pav.; *Baccharis poliantha* Kunth; *B. floribunda* Kunth; *B. riparia* Kunth; *Pluchea glabra* Griseb.; *Baccharis polyantha* f. *genuina* Hieron.; *B. polyantha* var. *macrophylla* Hieron; *Pingraea latifolia* (Ruíz & Pav.) F.H. Hellwig	AR, BO, CO, EC, PE, VE	"chilca" (Argentina); "aurauchu", "yurak-chilka" (Bolivia); "algodoncillo", "buéntsamo", "buétsemo", "chilca", "chilca blanca", "chilca negra", "chilca rucia", "chilco", "chilco blanco", "chilco negro", "chilquilla negra teñidora", "chirca", "chirco", "gurrubo" (Colombia); "chilca", "chilca negra", "chiza", "yana chilca" (Ecuador); "chilka" (Peru); "botonera", "niquitao" (Venezuela).	tonic, antidiabetic, antirrheumatic, vulnerary, emolient, disinfectant, for diarrhoea, for inflammation, for pulmonar affections (Correa & Yesid Bernal, 1990)	--

Species	Distribution	Vernacular name	Folk medicinal use	Tested biological activity
Baccharis linearis (Ruíz & Pav.) Pers. *Molina linearis* Ruiz & Pav.; *Baccharis rosmarinifolia* Hook. & Arn.; *B. lingulata* Less.; *B. linifolia* Meyen; *B. rosmarinifolia* var. *subsinuata* DC.; *B. callistemoides* Walp.; *B. subandina* Phil.; *B. rosmarinifolia* var. *callistemoides* (Walp.) Heering; *B. rosmarinifolia* var. *subandina* (Phil.) Heering; *B. holmbergii* Hicken	AR, CH	"romerillo" (Argentina).	for arterial blood, for pyorrhea (San Martín, 1983) antispasmodic, antirrheumatic, vulnerary, for inflammations, for wounds, for catarrh (Zin, 1922)	insect repelent, allelopathic, citotoxic, antifeedant (Verdi *et al.*, 2005)
Baccharis megapotamica Spreng. *Baccharis pyramidalis* Gardner	AR, BR, PA, UR	--	potentially medicinal	allelochemical, cerebral toxicity, antileukemic, antibiotic, antiinflammatory, analgesic (Verdi *et al.*, 2005)
Baccharis microcephala (Less.) DC. *Molina microcephala* Less.; *B. microptera* Baker	AR, BR, PA, UR	"carqueija", "carqueja" (Argentina); "carqueja", "cambará" (Brazil), "yaguareté-ka'á" (Paraguay).	digestive, hepatoprotective, antiseptic (Zardini, 1984)	--
Baccharis multiflora Kunth *Neomolina multiflora* (Kunth) F.H. Hellw.	ME	--	against catarrhs, for urinary problems (Heinrich, 1996)	--
Baccharis nitida (Ruiz & Pav.) Pers. *Molina nitida* Ruiz & Pav.; *Baccharis prinoides* Kunth; *B. cassinoides* auct. non DC.; *B. oronocensis* DC.; *B. popayanensis* Hieron.; *B. oronocensis* var. *perua* Cuatrec.; *B. nitida* f. *angustifolia* Cuatrec.; *B. lepidota* Gilli	BO, CO, EC, PE, VE	"chilca blanca", "chilco blanco", "chilco negro", "chilquilla arenilla", "espadero", "humadero" (Colombia).	for cough, for bronchitis, for pulmonar affections (Girault, 1987)	--
Baccharis notosergila Griseb. *Baccharis curtifolia* S. Moore	AR, BR, PA, UR	"carqueija", "carqueja" (Argentina).	antirrheumatic (Zardini, 1984)	antibiotic (Gutkind *et al.*, 1981) antimicrobial (Verdi *et al.*, 2005)
Baccharis odorata Kunth	CO, PE	--	for influenza, for colds, for bone fractures and dislocations (Girault, 1987)	--
Baccharis pedunculata (Mill.) Cabrera *Conyza pedunculata* Mill.; *Eupatorium cotinifolium* Willd.; *Baccharis cotinifolia* (Willd.) Urb.; *Pseudobaccharis cotinifolia* (Willd.) I.L. Teodoro; *Baccharis cinnamomifolia* Kunth; *Psila cinnamomifolia* (Kunth) Aristeg.; *Baccharis venusta* Kunth; *B. speciosa* DC.; *Eupatorium braunii* Pol.; *Baccharis braunii* (Pol.) Standl.; *B. splendens* Heering; *B. ibaguensis* Cuatrec.	AN, BO, CO, CR, EC, GU, HO, ME, NI, PN, PE, VE	"chilca", "chilca teñidora" (Colombia).	potentially medicinal	antifungal (Verdi *et al.*, 2005)

Species	Distribution	Vernacular name	Folk medicinal use	Tested biological activity
Baccharis pentlandii DC. *Baccharis fallax* Kuntze; *B. rubricaulis* Rusby	BO, PE	--	antirrheumatic, antiseptic, disinfectant, for cough, for pneumonia, for sprains, for bone fractures and dislocations (Girault, 1987)	gastroprotective, antiviral (Verdi *et al.*, 2005)
Baccharis pilularis DC. *Baccharis congesta* DC.; *B. consanguinea* DC.; *B. pilularis* var. *consanguinea* (DC.) Kuntze; *B. pilularis* subsp. *consanguinea* (DC.) C.B. Wolf	ME, US	"coyote brush" (US).	for treating hay fever, sinusitis, frontal headaches, to prevent baldness, as a female hygienic agent (Harding-Barlow, ined.)	--
Baccharis salicifolia (Ruíz & Pav.) Pers. *Molina salicifolia* Ruíz & Pav.; *M. striata* Ruíz & Pav.; *M. viscosa* Ruíz & Pav.; *M. parviflora* Ruíz & Pav.; *Baccharis glutinosa* Pers.; *B. parviflora* (Ruíz & Pav.) Pers.; *B. lanceolata* Kunth, *B. iresinoides* Kunth; *B. farinosa* Spreng.; *B. longipes* DC.; *B. coerulescens* DC.; *B. alamanii* DC.; *B. longifolia* DC.; *B. marginalis* DC.; *B. chilquilla* DC.; *B. linifolia* DC.; *B. viscosa* (Ruíz & Pav.) Kuntze; *B. viscosa* var.*nigricans* Kuntze; *B. marginalis* var. *longipes* Heering; *B. lanceolata* Kunth emend. Heering; *B. purpurascens* Heering; *Pingraea salicifolia* (Ruíz & Pav.) F.H. Hellwig; *P. viscosa* (Ruíz & Pav.) F.H. Hellwig	US, Central and South America	"chilca", "chilca amarga", "chilca blanca", "chilca dulce", "chilca hû", "chirca", "jarilla", "jarilla del río", "junco", "romerillo", "suncho", "vara dulce", "yuno" (Argentina); "chilca" (Bolivia); "chilca", "chilco" (Colombia); "axixtlacotl" (Mexico); "chilca" (Peru); "mulefat", "seep willow", "water wally" (US).	diuretic, against fevers, diaphoretic, for headache, for inflammation, for diarrhoea, for dysentery (Heinrich, 1996) antirrheumatic, antisyphilitic (Zardini, 1984)	--
Baccharis sarothroides A. Gray *Baccharis sarothroides* var. *pluricephala* Jeps.; *B. arizonica* Eastw.	ME, US	"desert broom" (US).	for colds, for relieving sore muscles (Heinrich, 1996)	citotoxic (Verdi *et al.*, 2005)
Baccharis scandens (Ruíz & Pav.) Pers. *Molina scandens* Ruíz & Pav.; *Baccharis adscendens* Pers.; *B. fevillei* DC.; *B. petiolata* DC.; *B. calliprinos* Griseb.; *B. mirabilis* Heering; *Pingraea scandens* (Ruíz & Pav.) F.H. Hellwig	AR, CH, PE	"chascoma", "chilca", "chilca dulce", "fía mate", "palo blanco", "suncho blanco" (Argentina).	laxative, expectorant, for bronchitis, for pulmonar affections (Girault, 1987) antirrheumatic, for wounds (Zin, 1922)	--
Baccharis serrifolia DC. *Baccharis kellermanii* Greenm.; *Archibaccharis prorepens* S.F. Blake; *Baccharis prorepens* (S.F. Blake) J.D. Jacks.	GU, HO, ME, NI	--	for gastrointestinal illnesses (Heinrich, 1996)	antispasmodic (Verdi *et al.*, 2005)
Baccharis teindalensis Kunth *Baccharis capitata* Kunth	CO, EC	--	antiinflammatory, analgesic, antimicrobial (Vidari *et al.*, 2003)	antiviral (Verdi *et al.*, 2005) antiulceral, antidiarrhoeic (Vidari *et al.*, 2003)

Species	Distribution	Vernacular name	Folk medicinal use	Tested biological activity
Baccharis tola Phil. *Baccharis microphylla* var. *incarum* Wedd.; *B. lejia* Phil.; *B. magellanica* var. *subviscosa* Kuntze; *B. magellanica* var. *subviscossima* Kuntze; *B. tola* var. *lejia* (Phil.) Reiche; *B. incarum* (Wedd.) Perkins; *B. tafiensis* Heering; *B. incarum* var. *lejia* (Phil.) Cabrera; *B. tola* var. *incarum* (Wedd.) Joch. Müller	AR, BO, CH, PE	"baila buen", "lejía", "tola", "tola lejía" (Argentina).	medicinal (Pérez-García *et al.*, 2001)	protein synthesis, antibacterial, antiinflammatory (Verdi *et al.*, 2005)
Baccharis tricuneata (L. f.) Pers. *Erigeron tricuneatum* L. f.; *Baccharis microphylla* Kunth	BO, CO, EC, PE, VE	"china-thula", "chilka", "hirwa-kowa" (Bolivia); "anisillo", "sanalotodo" (Colombia); "tayanqa" (Peru); "chilca", "sanalotodo" (Venezuela).	vulnerary, antidiabetic, antianemic, antirrheumatic, antiseptic, disinfectant, for wounds, for headache, for bronchitis (Correa & Yesid Bernal, 1990)	--
Baccharis trimera (Less.) DC. *Molina trimera* Less.; *Baccharis genistelloides* var. *trimera* (Less.) Baker	AR, BR, BO, PA, PE, UR	"carqueja" (Argentina, Brazil); "nuchu-kuchu", "quimsa-kuchu" (Bolivia), "yaguareté-ka'á" (Paraguay).	for renal affections, for varix (Correa & Yesid Bernal, 1990) digestive, hepatoprotective, antiseptic, for female sterility (Zardini, 1984)	vasorelaxant, moluscicide, antimutagenic, hepatoprotective (Verdi *et al.*, 2005)
Baccharis trinervis Pers. *Conyza trinervis* Lam.; *Baccharis laxa* Gardner; *Heterothalamus trinervis* (Pers.) Hook. & Arn.; *Pseudobaccharis trinervis* (Pers.) Badillo; *P. trinervis* (Pers.) I. L. Teodoro; *Psila trinervis* (Pers.) Cabrera	AR, BO, BR, CO, EC, GU, HO, ME, NI, PA, PE, PN, UR, VE	"chiñi kimsa kuchu" (Bolivia); "árnica", "barzalito", "barzalito de monte", "chaparral de bestia", "chilca", "chilquita", "chipolo", "gavilana", "lengua de gato", "machucha", "mandaguasca", "marucha", "varejón" (Colombia); "alcotan" (Ecuador); "Santa María" (Panama); "canaciche", "chilquita", "niquitaíto" (Venezuela).	antihemorrhoidal, antiinflammatory, antirrheumatic, for waist-ache, for jaundice, for male sexual impotence, for female sterility (Correa & Yesid Bernal, 1990) for treating fever, oedemas, sores, muscle cramps, gastrointestinal disorders (Heinrich, 1996)	antiviral, antiinflammatory, antioxidant (Verdi *et al.*, 2005)
Baccharis vaccinioides Kunth *Baccharis confertoides* G.L. Nesom	ES, GU, HO, ME	--	for gastrointestinal disorders (Heinrich, 1996)	--
Baccharis wrightii A.Gray	ME	--	for head disorders emetic (Boldt, 1989)	--

RESULTS AND DISCUSSION

Epidermal characters (Table 2)
Leaf pubescence. All studied species of *Baccharis* are pubescent (only a few, e.g. *B. dracunculifolia* and *B. trinervis* are subglabrous at maturity). Two major groups of indumentum can be distinguished within the medicinal species, one consisting of isolated trichomes and the other with trichomes in tufts (= "nidos pilosos", Ariza Espinar, 1973; = "Haarnester", Hellwig 1992).

Seven different types of trichomes were found:

(1) *Conical trichomes*: uniseriate, 5-6-celled with body gradually narrowed to a sharp point. Cells longer distally, often nodulose at the joints. Lateral and cross walls slightly thickened. This trichome type is present in *B. anomala* and *B. decussata.* (Fig. 1 A). Similiar trichomes were illustrated by Müller (2006) for *B. decussata* subsp. *jelskii* (*sub* "pedestal hair") and by Ariza Espinar (1973) for the non-medicinal *B. pulchella.*
(2) *Aseptate flagellate trichomes* (or whip trichomes, Metcalfe & Chalk 1989): uniseriate, 2-3-celled with body differentiated in stalk and a long, whip-like terminal cell. Stalk 1-2-celled, cells usually isodiametrical or broader than long.
(2) (a) *Simple*: terminal cell very long, flagellate, tubular, as wide as the cells of the stalk. This trichome type is present in *B. artemisioides* and *B. grisebachii* (Fig. 1 E), which have discolorous leaves with white-lanate abaxial surface. Trichomes of *B. artemisioides* were previously analyzed and illustrated by Ariza Espinar (1973) and Pertusi (1987). The aseptate flagellate trichomes of *B. grisebachii* were illustrated by Hellwig (1992) and by Müller (2006), *sub* "flagellate filiform" and "filiform hair" respectively.
(2) (b) *Branched*: three to five whip trichomes (with stalk 1-4-celled) appearing stellately branched from the only stalk cell. This trichomes type is present isolated only in *B. trinervis* (Fig. 1 B).
(3) *Filiform flagellate trichomes*: uniseriate, many-celled, body filiform to cilindrical and slightly tapering above. Cells usually broader than long, isodiametrical, or slightly longer than broad, with lateral walls convex. Terminal cell relatively short, tail-like and pointed (*B. multiflora, B. serrifolia* and *B. wrightii,* in the latter the trichomes are only found on the stem, Fig. 1 C) or pear-like and rounded at the apex (*B. megapotamica,* Fig. 1 D); those with tail-like apical cell can be straight or incurved. Dense contents have been seen in the terminal cell of these trichomes, which probably have secretory function.
(4) *1-armed trichomes*: uniseriate, 3-4-celled, with body differentiated into stalk and head. Stalk 2-3-celled, cells usually broader than long, lateral walls straight. Head 1-celled (occasionally branched at the base), with thick lateral and cross walls and pointed or rounded at the apex. This trichome type is present forming tufts or pilose nests only in *B. crispa* (Fig. 1 F). It was previously analyzed and illustrated by Ariza Espinar (1973) for *B. crispa*. Hellwig (1992) found trichomes 1-armed in a non-medicinal species, *B. rhomboidalis* and also in *B. macraei* and *B. pilcensis* (Hellwig, 1990).
(5) *2-4-armed trichomes*: uniseriate, 4-5-celled, with body differentiated into stalk and head. Stalk 3-4-celled, cells broader than long with lateral walls convex. Head 1-celled, cell 2, 3 or 4-branched (falls/collapsing at maturity). This trichome type is present forming tufts or pilose nests (associated or not to glandular trichomes) only in *B. dracunculifolia.* (Fig. 1 G). Müller (2006) described and illustrated these trichomes of *Baccharis dracunculifolia* as "uniseriate hairs with branched terminal cells". Hellwig (1992) found 4-armed trichomes in a non-medicinal species *B. erioclada*.

Table 2: Epidermal characters

Trichomes isolated or paired

Trichomes conical		Trichomes aseptate flagellate		Trichomes filiform flagellate	
Trichomes glandular present	Trichomes glandular absent	branched	simple	Trichomes with apical cell pear-like	Trichomes with apical cell tail-like
B. decussata	*B. anomala*	*B. trinervis*	*B. artemisioides*	*B. megapotamica*	*B. multiflora*
			B. grisebachii		*B. serrifolia*
					B. wrightii

Trichomes in tufts

Trichomes 2-4-armed	Trichomes 1-armed										
B. dracunculifolia	*B. crispa*	Trichomes bulbiferous flagellate subtype b			Trichomes bulbiferous flagellate subtype c						
		Apical cell triangular	Apical cell tail-like		Stomata large: 75-100µm long	Stomata medium: (35) 40-60 µm long			Stomata small: 20-30 µm long		
		Stomata cyclocytic	Stomata cyclocytic	Stomata actinocytic	*B. illinita*	Stomata anomocytic	Stomata actinocytic	Stomata cyclocytic	Anticlinal epidermal cell walls sinuate	Anticlinal epidermal cell walls straight	
		B. articulata	*B. heterophylla*	*B. conferta*		*B. douglasii*	*B. linearis*	*B. genistelloides*	*B. pentlandii*	Stomata anomocytic	Stomata actinocytic
		B. gaudichaudiana		*B. pilularis*		*B. genistifolia*	*B. nitida*			*B. latifolia*	*B. salicifolia*
		B. notosergila		*B. teindalensis*		*B. microcephala*	*B. odorata*			*B. scandens*	
				B. tricuneata		*B. pedunculata*	*B. sarothtoides*				
				B. vaccinioides		*B. tola*					

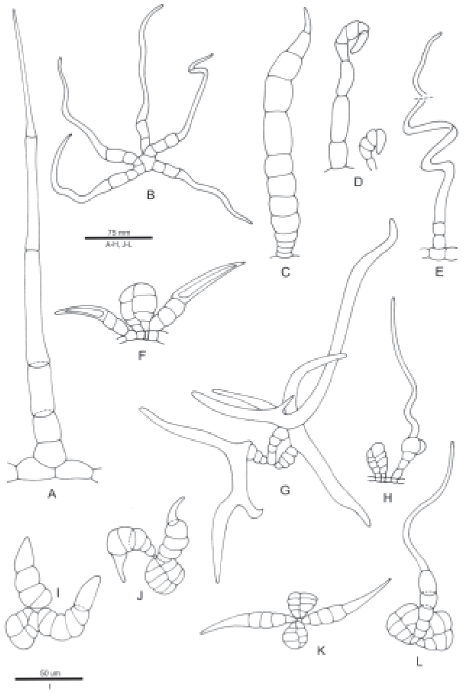

Figure 1. Trichomes.- A-E, Isolated trichomes. A: conical, *B. anomala,* B: aseptate flagellate branched, *B. trinervis;* C and D, Filiform flagellate. C: *B. multiflora;* D: *B. megapotamica;* E: aseptate flagellate simple, *B. artemisioides*; F-L, Tufted trichomes ("pilose nest") of eglandular trichomes and biseriate glandular trichomes. F: 1-armed trichome, *B. crispa;* G: 2-4-armed trichomes, *B. dracunculifolia;* H: bulbiferous flagellate, subtype a, *B. boliviensis;* I and J, Bulbiferous flagellate, subtype b. I: *B. notosergila;* J: *B. teindalensis;* K and L, Bulbiferous flagellate, subtype c. K: *B. pedunculata;* L: *B. tola.*

(6) *Bulbiferous flagellate trichomes*: uniseriate, 5-6-celled, usually forming tufts or pilose nests with glandular trichomes. According to the number of subapical cells and the lenght of the apical cell, three subtypes can be distinguished:

Subtype a: body differentiated into stalk and head. Stalk 2-3-celled, cells slightly longer than broad or isodiametrical, terminal cells of the stalk 2, swollen, sphaerical or oblong-ovoid in shape. Head 1-celled, long, flagellate. This trichome type is present only in *B. boliviensis.* (Fig. 1 H). Similar trichomes are also present in the unrelated non-medicinal *B. pingraea* (Hellwig, 1992).

Subtype b: body with cells usually enlarging above, resulting cuneate in shape. Terminal cell short with dense contents, broadly triangular (broadly triangular in *B. notosergila* or narrowly triangular in *B. articulata, B. gaudichaudiana,* and *B. trimera*) or more often tail-like, i.e. sharply delimited from the subapical cell (*B. conferta, B. heterophylla, B. pilularis, B. teindalensis, B. tricuneata, B. vaccinioides*). (Fig. 1 I, J). Trichomes of *B. articulata* and *B. trimera* were previously analyzed and illustrated by Pertusi (1987). Hellwig (1992) found trichomes with tail-like apical cell in the unrelated non-medicinal *B. paniculata*.

Subtype c: this type represents a modification of the *subtype a* with a differentiated head constituted by a flagellate cell, equal or longer than body, tapering above. This trichome type is present as isolated trichomes in three species, *B. anomala*, *B. coridifolia*, and *B. trimera*, and forms tufts or pilose nests in 16 of the 38 studied species. (Fig. 1 K, L). Bulbiferous trichomes with flagellate apical cell of the medicinal species *B. linearis* and *B. salicifolia* were previously illustrated by Ariza Espinar (1973) and Hellwig (1992) respectively. Müller (2006) illustrated for *B. coridifolia* two types of trichomes, i.e. bulbiferous flagellate subtype b (*sub* "uniseriate hairs") and aseptate flagellate (*sub* "filiform hairs").

(7) Biseriate glandular trichomes: such trichomes are constituted by 2 rows of cells in the body. Biseriate glandular trichomes are widespread in many taxa studied. They form tufts with non-glandular trichomes;

occasionally, tufts are constituted exclusively by two or three glandular trichomes (e.g. *B. vaccinioides*).

Stomata (Fig.2): eleven species (*B. boliviensis, B. conferta, B. linearis, B. nitida, B. odorata, B. pilularis, B. salicifolia, B. sarothroides, B. teindalensis, B. tola,* and *B. tricuneata*) have actinocytic stomata (Fig. 2 A, B), with five to seven subsidiary cells radially. One species (*B. crispa*) has anisocytic stomata (Fig. 2 C), with three subsidiary cells, of which one is smaller than the other two. Six species (*B. articulata, B. gaudichaudiana, B. genistelloides, B. heterophylla, B. illinita,* and *B. notosergila*) have cyclocytic stomata (Fig. 2 E, F), with four to seven subsidiary cells forming a narrow ring. In three species (*B. boliviensis, B. conferta, B. salicifolia*) with predominantly actinocytic stomata, a few tetracytic stomata are present (Fig. 2 B), which have four subsidiary cells, two lateral and two polar. Only one of this species (*B. conferta*) has also staurocytic stomata (Fig. 2 A), with four subsidiary cells with anticlinal walls arranged crosswise to its guard cells. The remaining species have anomocytic stomata (Fig. 2 D, G).

Cyclocytic stomata in *B. articulata*, anisocytic stomata in *B. trimera*, and anomocytic stomata in *B. artemisioides* were previously reported by Pertusi (1987). Ariza Espinar (1973) analyzed and illustrated actinocytic stomata in *B. salicifolia* (anomocytic *sensu* Ariza Espinar), anomocytic stomata in *B. coridifolia*, and anisocytic stomata in *B. crispa* (anomocytic *sensu* Ariza Espinar).

The majority of the species have stomata between 20 to 60 µm long. In only three species the stomata are more than 60 µm long, i.e. *Baccharis articulata* and *B. gaudichaudiana*, between 60 to 75 µm long, and *B. illinita* with stomata between 75 to 105 µm long.

Most of the species analyzed have amphistomatic leaves, only twelve species, i.e. *Baccharis anomala*, *B. decussata*, *B. dracunculifolia*, *B. grisebachii*, *B. heterophylla*, *B. illinita, B. latifolia*, *B. megapotamica, B. multiflora, B. pedunculata, B. serrifolia*, and *B. trinervis.*

Anticlinal epidermal cell walls (on abaxial surface): only three species (*B. anomala*, *B. decussata*, and *B. pentlandii*) amongst the medicinal species, have sinuate anticlinal wall (Stace's types 5-6). The remaining species have straight to slightly undulate anticlinal walls (Stace's types 1-2).

CONCLUSIONS

Certain anatomical characters allow to the distinction of medicinal species of *Baccharis*. For example: 1) *B. trinervis* is recognized from other medicinal species by its branched aseptate flagellate trichomes that are unique within the whole genus; 2) filiform trichomes with pear-like apical cell are exclusive of *B. megapotamica*; 3) only two species, among medicinal species, *B. artemisioides* and *B. grisebachii*, have aseptate flagellate trichomes; 4) *B. boliviensis* and *B. dracunculifolia* can be recognized among medicinal species by its bulbiferous trichomes with two subapical cell and 2-4-armed trichomes, respectively; 5) *B. illinita* is distinguished from other medicinal species by its large stomata of 75-100 µm.

Other characters, such as stomata type and epidermal cell walls, can be used to differentiate species with similar type of trichomes, as a secondary feature. In *B. articulata*, *B. gaudichaudiana*, *B. notosergila*, and *B. trimera*, the trichomes are bubiferous flagellate with triangular apical cell; however, *B. trimera* can be distinguished by its anisocytic stomata. In *B. heterophylla* the trichomes are bulbiferous flagellate with tail-like apical cell, as well as in *B. conferta*, *B. pilularis*, *B. teindalensis*, *B. tricuneata*, and *B. vaccinioides*; however, *B. heterophylla* can be differentiated from them by its cyclocytic stomata. *Baccharis pentlandii* has

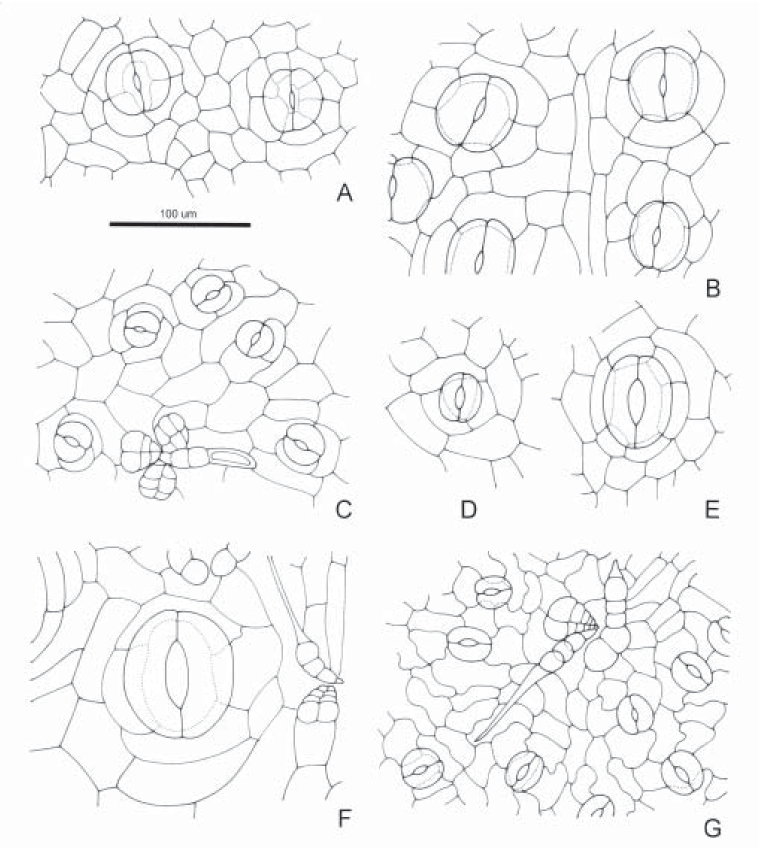

Figure 2. Stomata.- A: actinocytic and staurocytic stomata, *B. conferta;* B: actinocytic and tetracytic stomata, *B. boliviensis;* C: anisocytic stomata, *B. crispa;* D: anomocytic stomata, *B. trimera;* E: cyclocytic stomata, *B. notosergila;* F: cyclocytic stomata, *B. illinita;* G: anomocytic stomata, *B. pentlandii.*

bulbiferous flagellate trichomes with long apical cell, which is a common type within medicinal species, but it can be distinguished by its sinuate anticlinal epidermal cell walls on abaxial surface.

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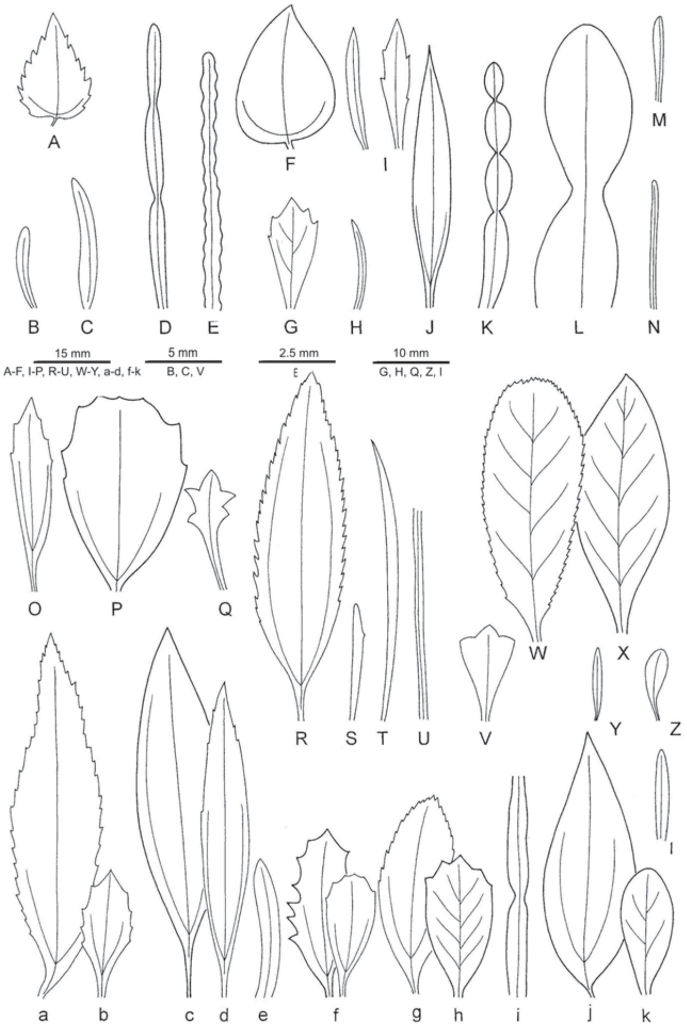
Appendix 1. *Baccharis* species used in traditional medicine

A-C: Leaves. A, *B. anomala;* B, *B. boliviensis*; C, *B. artemisioides*; D, E: Stems. D, *B. articulata*; E, *B. crispa*; F-J: Leaves. F, *B. decussata*; G, *B. conferta*; H, *B. c*o*ridifolia*; I, *B. dracunculifolia;* J, *B. douglasii*; K, L: Stems. K, *B. gaudichaudiana*; L, *B. genistelloides*; M-T: Leaves. M, *B. genistifolia*; N, *B. grisebachii*; O, *B. heterophylla*; P, *B. illinita*; Q, *B. tola*; R, *B. latifolia*; S, *B. linearis*; T, *B. megapotamica*; U: Stem. *B. microcephala*; V-h: Leaves. V, *B. tricuneata*; W, *B. multiflora*; X, *B. nitida*; Y. *B. notosergila*; Z, *B. odorata*; a, *B. pentlandii*; b, *B. pilularis*; c, *B. pedunculata*; d, *B. salicifolia*; e, *B. sarothroides*; f, *B. scandens*; g, *B. serrifolia*; h, *B. teindalensis;* i: Stem. *B. trimera*; j,k: Leaves. j, *B. trinervis*; k, *B. vaccinioides*; l, *B. wrightii.*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Appendix 2. Representative specimens examined of *Baccharis* (one specimen per species is cited).

Baccharis anomala. BRASIL. Santa Catarina: Capinzal, *Smith et Klein 11917* (LP).
B. artemisioides. ARGENTINA. Buenos Aires: Pedro Luro, *Cabrera 4514* (LP).
B. articulata. ARGENTINA. Buenos Aires: Elizalde, *Cabrera 1799* (LP).
B. boliviensis. ARGENTINA. Jujuy: Yavi, Quebrada del Lecho, *Tolaba et al. 1591* (LP).
B. conferta. MEXICO. Distrito Federal: Cañada de Contreras, *Hernández 1* (LP).
B. coridifolia. ARGENTINA. Buenos Aires: San Nicolás, *Cabrera 7161* (LP).
B. crispa. ARGENTINA. Córdoba: Tulumba, San Pedro Norte (Chico), *Luti 4148* (LP).
B. decussata. COLOMBIA. Cundinamarca: Pacho-Paime, *Haught 6060* (LP).
B. douglasii. UNITED STATES. California: Orange County, *Raven 16861* (GH).
B. dracunculifolia. ARGENTINA. Jujuy: Valle Grande, *Cabrera & Fabris 22678 (LP).*
B. gaudichaudiana. ARGENTINA. Misiones: Apóstoles, *Cabrera et al. 28469* (LP).
B. genistelloides. PERU. Amazonas: Chachapoyas, *Wurdack 497* (LP).
B. genistifolia. ARGENTINA. Buenos Aires, Necochea, *Cabrera 1289* (LP).
B. grisebachii. ARGENTINA. Jujuy: Humahuaca, *Kiesling et al 614* (LP).
B. heterophylla. MEXICO. Michoacan: Lack Patzcuaro, *T. C. Frye & E. M. Frye 2593* (GH).
B. illinita. BRASIL. Rio Grande do Sul: Criuva-San Francisco de Paula: Arroio das Muladas, *Irmão Edēsio 121* (LP).
B. latifolia. ARGENTINA. Salta: Los Yacones, *Zardini 1197* (LP).
B. linearis. ARGENTINA. Río Negro: Bariloche, *Cabrera 5827* (LP).
B. megapotamica. PARAGUAY. Caaguazú: Caaguazú, *Schinini 9140* (LP).
B. microcephala. ARGENTINA. Misiones: Posadas, *Ekman 213* (LP).
B. multiflora. MEXICO. Guerrero: Near Chilpancingo, *Nelson 2205* (GH).
B. nitida. PERU. Amazonas: Leimebamba. *Sagástegui 7448* (LP).
B. notosergila. ARGENTINA. Buenos Aires: Bavio, *Zardini 593* (LP).
B. odorata. PERU. Áncash: Bolognesi, Rumipuquio, *Cerrate et al. 6508* (LP).
B. pedunculata. NICARAGUA. Jinotega: Between Matagalpa and Jinotega, *Stevens & Krukoff 10074* (F).
B. pentlandii. BOLIVIA. La Paz: Miraflores, *Buchtien 8592* (LP).
B. pilularis. UNITED STATES. California: Marin County, *Solbrig 1927* (LP).
B. salicifolia. ARGENTINA. Corrientes: Gral. Paz, Rincón de Vences, *Pedersen 6983* (LP).
B. sarothroides. MEXICO. Sonora: Nacore Chico, *Muller 3693* (GH).
B. scandens. ARGENTINA. San Juan: Iglesia, Cerro Antecristo, *Kiesling et al. 9164* (LP).
B. serrifolia. GUATEMALA. Alta Verapaz, *Hunnewell 17272* (GH).
B. teindalensis. COLOMBIA. Nariño: Macizo del volcán Galeras, *Cuatrecasas & Mora 26940* (US).
B. tola. ARGENTINA. Jujuy: Tumbaya, Trancas, *Cabrera et al. 22513* (LP).
B. tricuneata. COLOMBIA. Antioquia: Santa Helena, *Astrágala 25* (LP).
B. trimera. ARGENTINA. Buenos Aires: La Plata, *Cabrera 464* (LP).
B. trinervis. ARGENTINA. Jujuy: Ledesma, Valle Grande, *Cabrera et al. 14516* (LP).
B. vaccinioides. MEXICO. Chiapas: San Critóbal de Las Casas, *Méndez Ton & López 9546* (GH).
B. wrightii. MEXICO. Chihuahua: Valley Ortiz, *Pringle 1658* (LP).